



TECHNICAL MEMORANDUM

TO: Nicholas Stern/California Department of Justice, Office of Attorney General
FROM: Nicholas M. Johnson/Water Resources Consultant
DATE: June 15, 2000
SUBJECT: Comments on California Energy Commission staff report, *Preliminary Water Supply Assessment* [re: Three Mountain Power Project], by L. Bond, June 1, 2000

The subject document represents a valuable addition to our growing understanding of the Burney basin hydrologic system. It builds on the existing interpretations of water isotope work conducted by investigators for Lawrence Livermore National Laboratory (LLNL), and presents an original interpretation of the basin's average annual evapotranspiration. Recent and continuing efforts by others are also contributing to this understanding, including spring gaging and additional isotope sampling by consultants for both the applicant and interveners. Early indications suggest that some of these data will help to further refine the basin's average annual water balance¹.

As stated in the concluding remarks of the subject staff report, the report does not speculate regarding specific hydrologic impacts that may potentially occur as a result of the proposed project. This may be appropriate, inasmuch as several potentially significant hydrologic impacts may be more associated with critical dry-year conditions than the average-annual conditions discussed in the staff report.

As the hydrologic consultant addressing the concerns of the California Department of Parks and Recreation, I provide the following preliminary comments regarding specific, potentially significant hydrologic impacts associated with the proposed project.

Potential Patterns of Groundwater Flow

In its technical presentations, the applicant has assumed that essentially all of the groundwater proposed for extraction for cooling purposes would otherwise discharge as springflow to Burney Falls. Some have interpreted LLNL's isotope data to indicate that relatively separate sources of groundwater may exist for the proposed wells and the falls. Nevertheless, the following points indicate that it is appropriate to make the conservative assumption that the proposed wells would effectively intercept a commensurate portion of the fall's discharge:

- Additional data collected recently suggest that the isotopic character of groundwater discharging to the falls is quite variable depending on where the sample is collected.
- Even if the falls are partially fed by groundwater originating from different areas than the proposed wells, it is reasonable to expect that these wells will alter the groundwater flow pattern and in so doing divert equivalent rates of groundwater flow away from the falls.

¹ For example, it appears that recent, more comprehensive sampling for isotopes at Burney Falls than conducted by LLNL will enable some refinement of the interpreted sources of flow to the falls.



- The volume of groundwater discharging to the falls is sufficiently large that most of the Burney basin must be considered as a source area in order to account for the required volume of groundwater recharge.

Potential Impact to Burney Falls

The applicant has estimated that the proposed project's groundwater pumping will diminish the flow of Burney falls an average of about 2 percent during average years and an average of less than 3 percent during drought years, and deemed this insignificant. However, it is appropriate to address the potential impact to the falls during the driest period of a drought, not the average drought condition. While my written expert testimony will elaborate further on the shortcomings of the applicant's method of estimating impacts, I wish to present here an alternative, preliminary assessment of the potential impact to the falls.

Table 1 summarizes the available measured flows of Burney Falls. The historic data suggest that low flows at the falls have diminished over time, perhaps as a result of other consumptive uses of water in the basin since the time of the earlier measurements. With continued future development, it is reasonable to expect that the fall's low flows will continue to diminish, even without the proposed project.

The lowest measurement, 122 cubic feet per second (cfs), was made by State Fish and Game staff in September 1994. The project's proposed pumping of approximately 3,000 acre-feet per year (ac-ft/yr) is equivalent to 4.14 cfs. Thus, the project's pumping would have depleted the flow of the falls by about 3.5 percent under these conditions.

Figure 1 plots measured low flows at the falls during the recent 1987-1994 drought. As predicted by the theory of groundwater hydraulics, this drought flow recession curve approximates a straight line when plotted semilogarithmically. Note that the wet water year in 1993 did not prevent flows from continuing along this drought trend during dry 1994.

Table 2 presents data summarizing the region's long-term climatic record. Figures 2, 3, and 4 are plots of precipitation and streamflow during the past century as a percentage of average water-year conditions. These plots clearly show that a significant drought occurred between approximately 1915 and 1935. This approximately 20-year drought far surpassed the length of the recent 1987-1994 drought.

Figure 5 extrapolates the fall's low-flow recession curve from Figure 1 over a hypothetical 2001-2020 drought similar to the one that occurred prior to 1935. By the end of this period, the low flows at the falls would diminish to less than 60 cfs. In such a case the proposed pumping would diminish the flow of the falls by about 7 percent.

The applicant has estimated that the consumptive use of groundwater in Burney basin may increase by 4,000 ac-ft/yr by 2030. As a result, the cumulative impact to Burney Falls would be more than double that of the proposed 3,000 ac-ft/yr pumping for power-plant cooling. During the drought condition described above, the resulting cumulative impact to the falls would be a reduction in low flow of approximately 16 percent.

One last point regards the nature of groundwater discharge to the falls. The falls are fed both by springs at the top of the falls and by springs mid-way up the falls. As summarized in Table 1, only about 70 percent of the low flow is estimated to come over the top of the falls. The proposed groundwater pumping will result in lowered groundwater levels that will have the greatest effect on the high elevation springs at the top of the falls. Assuming the impact of the pumping is entirely felt by the upper springs, their low flows would diminish by 10 percent under current conditions, and 23 percent with the cumulative impact of future consumptive uses.

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In conclusion, the proposed project's consumptive use of groundwater represents a significant potential impact to the low flows of Burney Falls during drought conditions.

Table 1
Preliminary Summary of Available Discharge Record for Burney Creek at Burney Falls

Measurement Date(s)	Water-Year Precip. as % of Avg.	Water-Year Pit R. Flow as % of Avg.	Discharge (cfs)			Source of Flow		Data Source
			Single Measure- ment	Lowest Value for Measured Period		Springs above Falls	Springs within Falls	
Sep 9, 1903	101%	122%	210					USGS, 1927: Water Supply Paper 557
Sep 25, 1920	62%	43%	246					
Mar-Sep, 1921	108%	148%		141	Sep 29			USGS, 1960: Water Supply Paper 1315-A
Oct 1921-Sep 1922	93%	73%		148	Oct-Dec			
				148	Sep 30			
Sep 1988	80%	34%	183					CH2M HILL, 1988
Oct 17, 1991	81%	62%	130					PG&E, written communication
Nov 6, 1991	(WY 1991)		130					
Jun 4, 1992	55%	14%	142					
Sep 8, 1994	68%	37%	122			72%	28%	Calif. Dept. Fish & Game, written communication
May 2000	-	-	160			63%	38%	Dames and Moore, June 2000: CEC Data Request 127
	(source: Table 2)							

Table 2
Preliminary Summary of Long-Term Climatic Record

Water Year	Precipitation Stations							Pit River as % of Avg.	Eel River Flow as % of Avg.
	Burney	Burney Falls SP	Hat Creek	Marysville	Yreka	Happy Camp	Estimated % of Avg		
1901				25.14	24.01		120%	109%	
1902				19.42	18.30		98%	140%	
1903				21.26			101%	122%	
1904								210%	
1905				24.02	18.57		107%	94%	
1906				27.80	20.33		117%	135%	
1907				32.04			141%	176%	
1908				16.91			85%	98%	
1909				21.47			102%	203%	
1910				18.73			92%	145%	
1911				26.42			121%	163%	77%
1912				14.16			75%	112%	66%
1913				11.36			65%	96%	98%
1914				28.52			128%	153%	161%
1915				27.57	13.78		103%	64%	100%
1916				21.69	18.06	51.05	99%	70%	100%
1917				16.90	11.50	36.42	76%	156%	79%
1918				15.23	13.97	35.38	77%	54%	41%
1919					17.57	45.43	92%	78%	98%
1920				11.70	9.72	27.39	62%	43%	26%
1921				25.08	20.52	53.36	108%	148%	145%
1922				21.02	14.79		93%	73%	67%
1923				22.78	16.02	28.93	86%	49%	48%
1924				10.95	6.87		57%	31%	15%
1925				26.13	27.84		131%	83%	131%
1926				20.95	10.28		83%	31%	58%
1927				26.59	27.49		131%	149%	144%
1928				17.28	14.45		85%	100%	83%
1929				14.04	10.73	34.67	70%	44%	33%
1930				20.87	16.69		97%	54%	63%
1931				12.04	11.97		70%	15%	28%
1932			16.40	17.35	15.25	44.73	90%	87%	65%
1933			13.46	12.68	13.87	53.78	75%	34%	65%
1934			14.21	14.06	12.29	36.07	79%	13%	45%
1935			22.72	23.40	13.84	48.92	123%	72%	93%
1936			18.38	22.72	19.20	48.21	100%	97%	106%
1937			16.31	21.88	13.90	37.42	90%	57%	65%
1938			22.91	28.78	27.43	85.23	124%	227%	200%
1939			10.55	9.66	11.15	37.30	60%	39%	48%
1940			20.12	26.90	21.39	65.75	110%	73%	134%
1941			25.95	33.46	20.53	59.31	140%	87%	152%
1942			25.49	28.95	22.18	53.64	138%	132%	137%
1943			26.35		21.35	61.45	142%	158%	105%
1944	15.26		14.17	19.96	11.86	36.81	56%	53%	40%
1945	23.26		16.53	19.72	14.82	53.60	85%	100%	87%
1946	28.29		17.46	17.68	17.68	65.15	104%	77%	111%
1947	22.96		14.62	14.86	12.23	44.53	84%	37%	47%
1948	37.89		23.83	20.82	21.01	55.32	139%	77%	87%
1949	17.44		11.55	13.87	11.79	37.71	64%	94%	76%
1950	22.59		16.11			53.16	83%	58%	75%
1951	26.51		16.25	23.28	24.29	67.69	97%	76%	131%
1952	39.48		26.49	31.15	23.93	70.90	144%	236%	147%
1953	30.41		18.53	19.43	23.31	72.80	111%	131%	131%
1954	26.36		13.44	17.97	21.26	67.22	96%	67%	127%
1955	18.13		11.52	15.85	7.53	36.20	66%	39%	57%
1956	41.93		27.19	30.39	30.94	81.27	153%	200%	188%
1957	25.05		15.36	17.73	17.32	54.25	92%	130%	79%
1958	36.16		24.58	30.65	26.38	87.17	132%	159%	216%
1959	20.86		13.15	15.27	10.30	47.38	76%	36%	75%
1960	21.39		13.44	13.98	13.75	44.27	78%	45%	85%
1961	25.68		18.48		20.47	55.96	94%	22%	97%
1962	23.45		14.88	16.76	15.87	43.48	86%	46%	71%
1963	37.59		26.71	28.21	22.69	61.71	138%	168%	129%
1964	19.38		12.64	15.50	14.87	46.56	71%	80%	63%
1965	33.89		20.70	19.04	25.73	65.38	124%	187%	174%
1966	20.60		12.39	12.46	12.07	53.10	75%	37%	93%
1967	38.72		23.68	29.52	18.52	58.57	142%	106%	120%
1968	26.79		18.69	16.07	15.13	46.02	98%	54%	76%
1969	38.56		23.63	29.07	20.76	56.67	141%	156%	159%
1970	35.67		23.73	22.16	23.90	57.71	131%	145%	138%
1971	38.52		26.87	19.12	25.76		141%	262%	146%
1972	20.99		14.93	13.81	19.92	58.37	77%	151%	85%
1973	26.14		17.09	29.94	11.86	38.40	96%	74%	111%
1974	41.41		27.44	28.35	27.99	86.80	152%	129%	222%
1975			18.07	22.37	19.15	55.61	99%	128%	130%
1976	14.14			11.23	18.21	41.81	52%	45%	51%
1977	11.21	22.54	9.45	7.68	9.32	23.71	41%	24%	8%
1978	31.87	33.4	23.63	29.29	26.80	56.28	117%	66%	146%
1979	23.42	37.29	18.08	19.99	12.31	31.99	86%	60%	57%
1980	33.65	33.74	26.29	23.72	22.33	55.27	123%	130%	129%
1981	22.58	40.65		19.32	13.26	36.34	83%	38%	59%
1982	37.98	44.41	26.86	32.91		83.69	139%	165%	198%
1983	42.63	52.94	26.97	36.97	25.05	86.78	156%	166%	235%
1984	25.63	28.81	18.99	26.84		56.03	94%	193%	127%
1985	23.29	22.72	17.66	15.45			85%	69%	70%
1986	34.61	38.97				57.40	127%	192%	138%
1987	20.07	27.36	13.21			38.37	73%	35%	60%
1988		22.68		17.84			80%	34%	57%
1989	27.76	25.13	20.63	21.51		49.89	102%	82%	84%
1990	17.57	19.34		15.01	15.83	38.52	64%	27%	47%
1991		23.61	14.82	19.41	16.39	29.92	81%	62%	33%
1992	15.14	22.73	8.40	20.49			55%	14%	41%
1993		36.35	27.65	30.78			131%	134%	133%
1994		22.64		14.92	9.57	28.84	68%	37%	40%
1995		49.58			25.03	70.55	133%	218%	188%
1996		46.16		24.35	27.26		129%	176%	132%
1997		26.29			29.97	66.76	117%	142%	141%
1998								211%	182%

Data Sources:
NOAA
Calif. Dept. Parks & Rec.
USGS
SWRB

Figure 1
Preliminary Interpretation of Burney Falls Low Flow Recession During 1987-1994 Drought

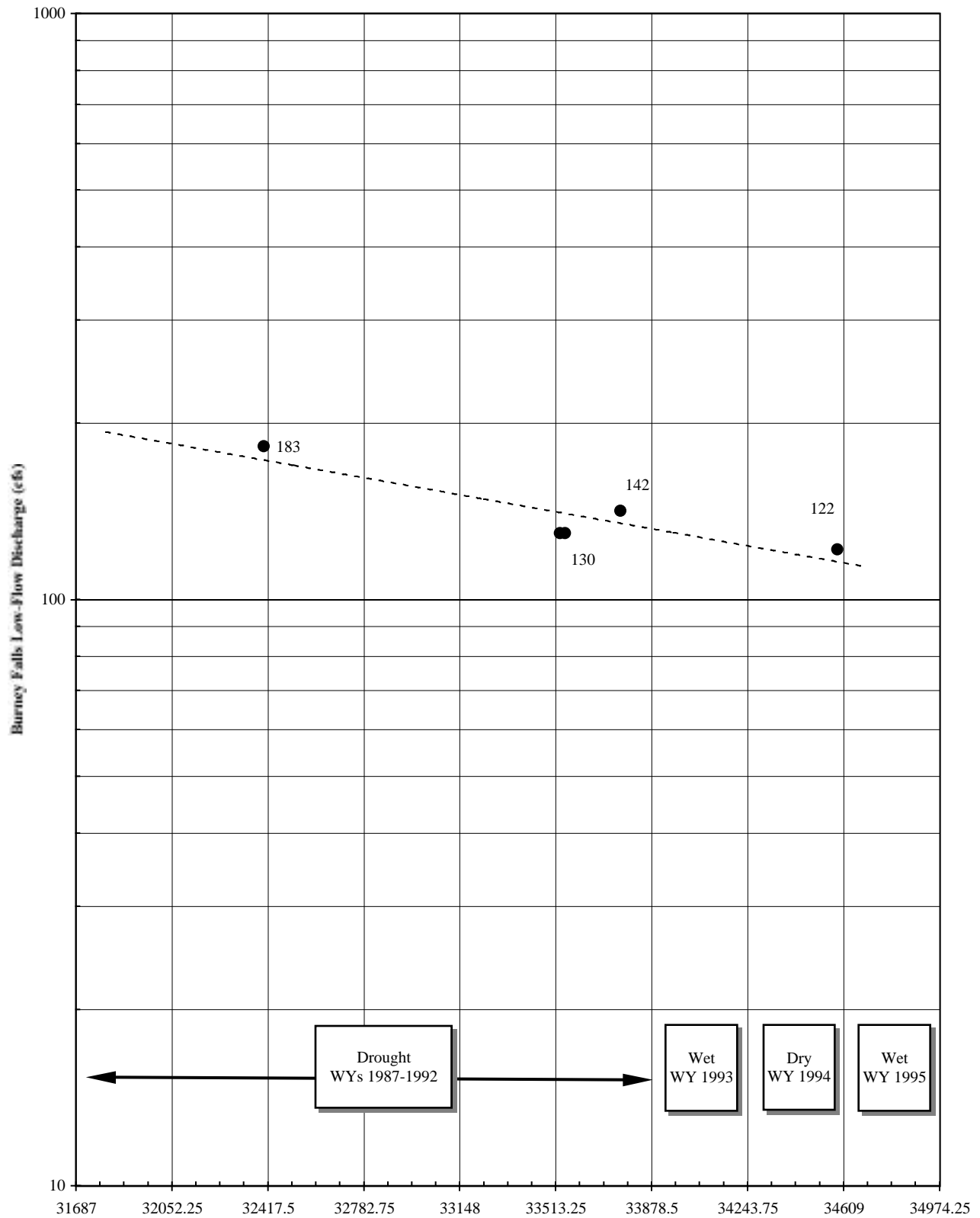


Figure 2 (Preliminary)
Recorded and Estimated Precipitation at Burney as a Percent of Long-Term Water-Year Average

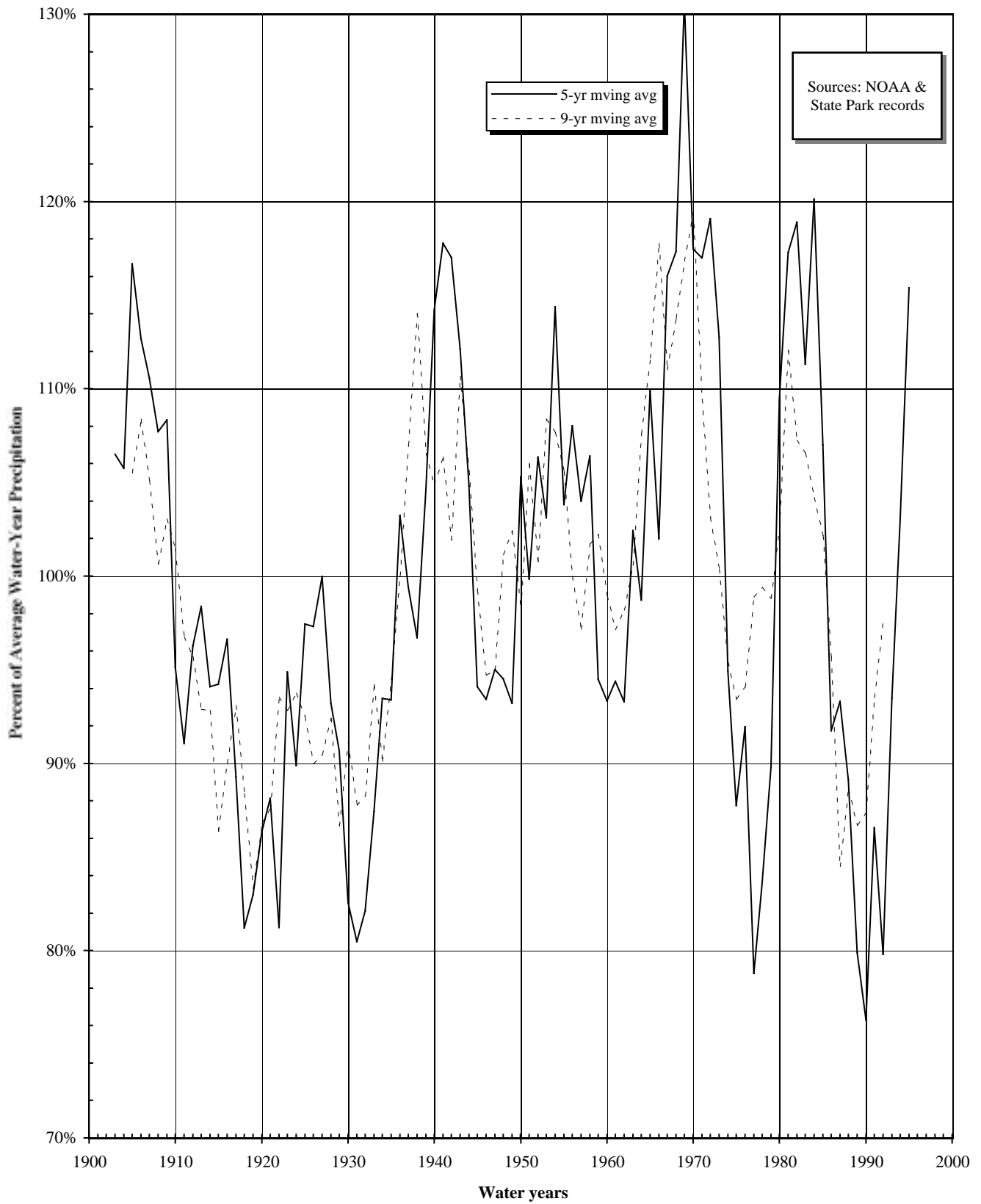


Figure 3 (Preliminary)
Discharge of Pit River near Canby as a Percent of Long-Term Water-Year Average

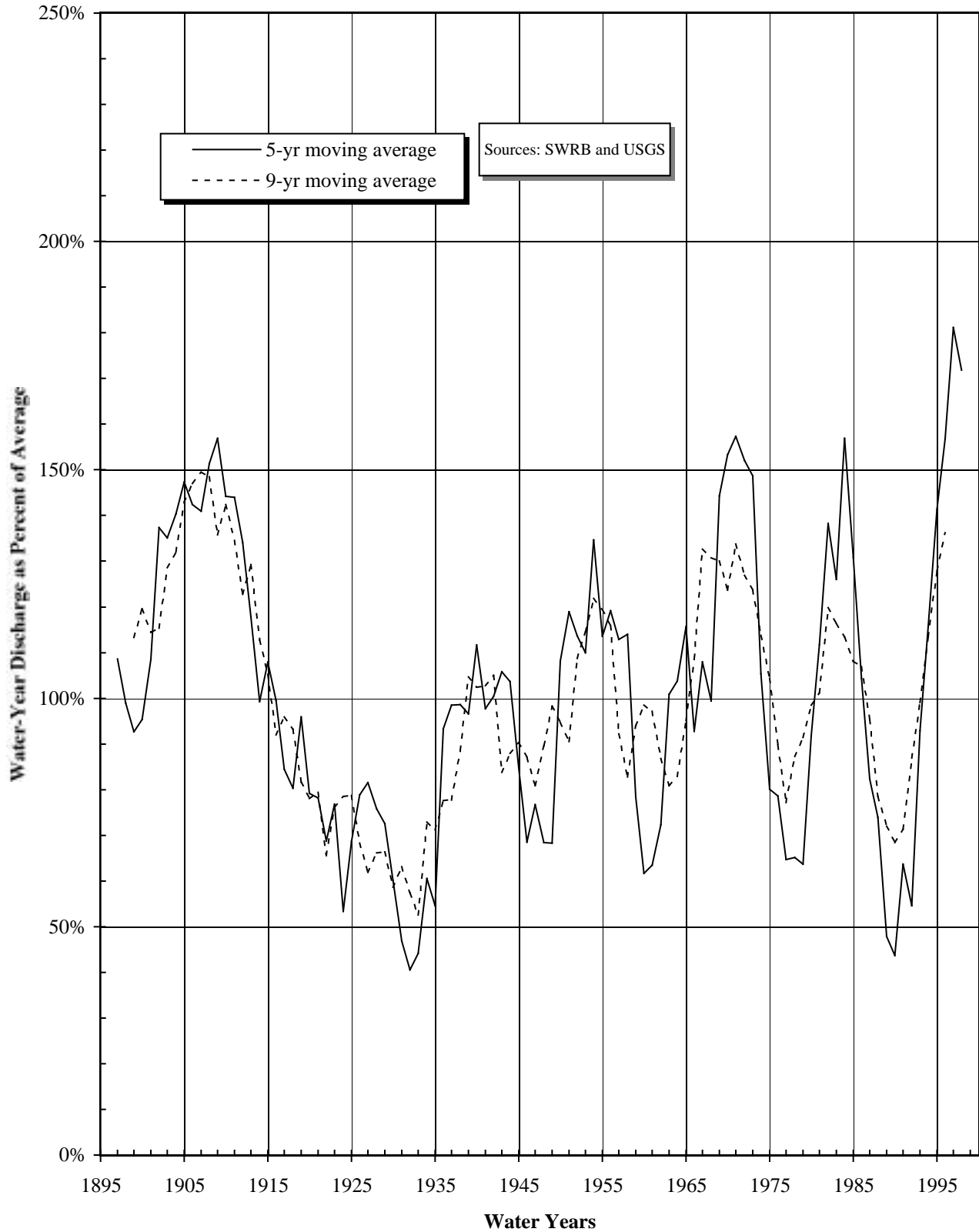


Figure 4 (Preliminary)
Discharge of Eel River at Scotia as Percent of Long-Term Water-Year Average

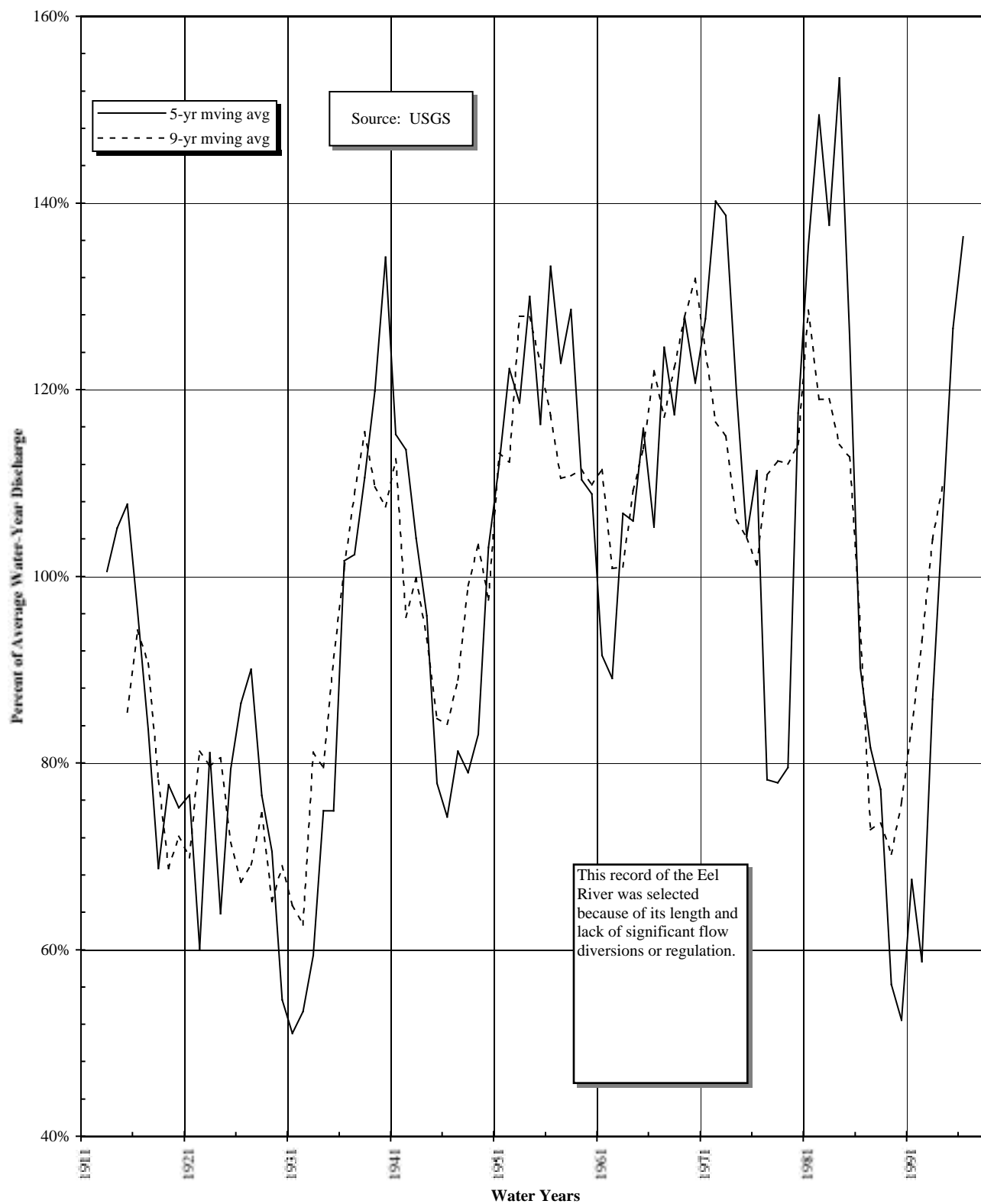


Figure 5
Preliminary Projection of 1987-1994 Decline in Burney Falls Low-Flow Discharge through an Extended Drought
Similar to 1915-1935

